CHAPTER 5. PREPARATION OF ENGINEERING PLANS

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Contents

Figures

CHAPTER 5. PREPARATION OF ENGINEERING PLANS

1. GENERAL

DEFINITION

The preparation of engineering plans is the orderly process of collecting, recording, and analyzing all the facts and data needed to arrive at a satisfactory solution to a problem.

The final engineering plan usually is presented by graphic and narrative methods which outline the kind, scope and quality of work to be accomplished.

INTRODUCTION

The material presented is to be used as a guide in analyzing site conditions and preparing engineering plans.

Of primary importance is the need for technicians to collect sufficient data to permit them to identify the problem and its scope before attempting to develop a plan for getting rid of the problem.

Of equal importance is the need to: 1) Follow a systematic approach in the collection of site information; 2) consider alternate solutions; and 3) use accepted procedures for developing designs and plans for conservation measures as outlined in this manual.

This chapter has application in the development of plans and specifications for conservation practices that are normally developed and installed by the work unit staff, using standard forms, designs, and specifications. However, it also includes elements of the engineering process required for more complex plans.

2. PLANNING PROCEDURES

GENERAL

Certain basic steps should be taken in analyzing the problem and preparing the engineering plan for conservation measures, regardless of the size and complexity of the work. The same process of thought and action applies whether the job involves a simple irrigation turnout structure or a large dam or major group enterprise.

The basic steps are:

1. Identification of the problem and its scope.

2. Site investigation.

3. Collection of basic design data.

4. Assembly and analysis of data.

5. Design.

6. Preparation of plans and specifications.

7. Review and approval of plan.

The work unit technician needs to recognize the importance of an early appraisal of the size and complexity of the job in terms of classification and approval. Project requests that apparently are in a class beyond the scope of the work unit's approval should be referred immediately to a higher level. Such timely action may prevent the loss of valuable time.

COLLECTING DATA

Identification of the Problem

Owner's Proposal

A clear understanding of the objectives of the proposed measure(s) is essential. The specific requirements should be discussed with the cooperator on the site. Often the cooperator has given considerable thought to the problem and its solution, and his suggestions may be helpful in analyzing the problem and its scope.

Need and Feasibility

In the preliminary review of the proposal, consideration should be given to the existing and potential damages and the feasibility and need for the work. Requests for structures or practices that apparently are not feasible or needed should be fully discussed with the cooperator and other interested parties, leading to withdrawal of the request or acceptance of an alternate measure.

Alternate Methods

After considering the site conditions and objectives to be met, consideration needs to be given to other solutions that appear to have merit. The more desirable alternates should be discussed with the cooperator. Further investigation and planning is then directed to the analysis of those corrective methods.

Site Investigations

Available Data

The site should be studied to define the detail and extent of the needed investigations. All available data, such as soils, geology, hydrology, and climatology of the site should be reviewed and a decision made as to the amount of additional data required to design the conservation practice. Consideration of pertinent data that may be available in reports or papers prepared outside the Service also may be helpful.

Collecting Additional Data

Arrangements for collecting additional data usually need to be started at an early date. Occasionally the cooperator will be asked to help in collecting the data. His assistance should be discussed and a firm schedule agreed upon. Service personnel and equipment also should be scheduled so that action may proceed in an orderly manner.

Collecting Basic Design Data

General

The following items represent data that may be required to develop an engineering plan. All items may not apply for the average situation, but additional investigations will be required for complex projects. The technician should carefully analyze the available data and arrange for the collection of the additional information needed.

Watershed Map

All watershed information pertinent to the analysis and design of the proposed works should be assembled and recorded on a prepared form or a map. The degree of detail needed will depend upon the complexity of the structure or measure. Watershed information used for the analysis and solution of the problem requires determination of the contributing watershed, characteristics of the watershed, and the location of the proposed works in the watershed. Such information may include some or all of the following: (See Figure 5-1.)

1. Average slopes of various reaches of the principal watercourses.

2. Average slope of the land in various parts of the watershed. (Generally this can be obtained from the soil survey map.)

3. Land use broken down into cropland, grassland and woodland.

4. Area of each of the predominant soil types or groups within the watershed.

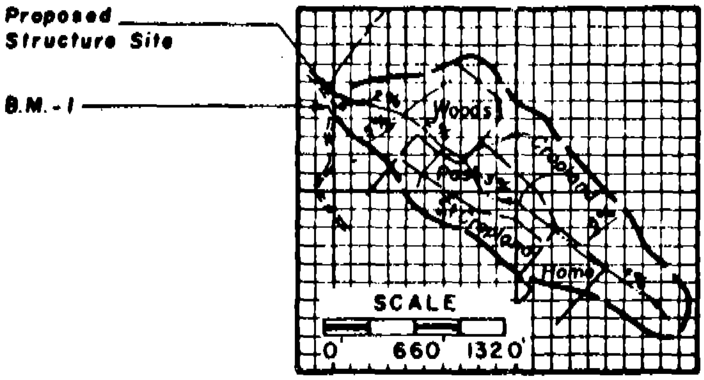
5. Location of the proposed work, by symbol.

6. Section or subdivision corners and legal description.

7. Names and extent of property ownership on large watersheds.

A watershed map may be prepared by one or a combination of the following methods:

1. Drawing information on an aerial photograph.



Traced from aerial photograph

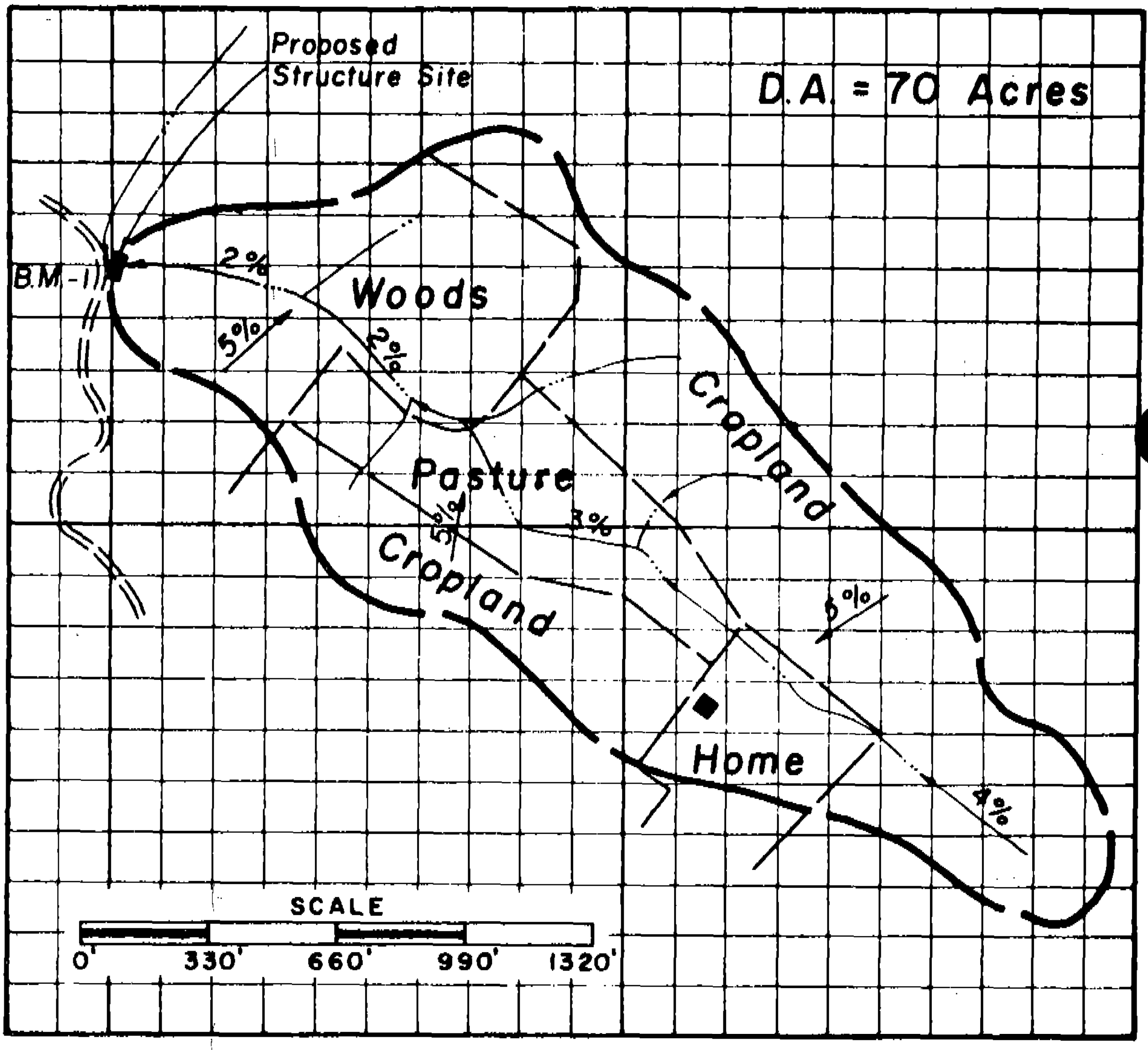


Figure 5-1 Example of enlargement of watershed planning map

2. Tracing from aerial photograph to a work sheet.

3. Enlarging aerial photograph data by proportioning on cross-section paper or enlarging directly with a pantograph.

4. Drawing information on a USGS topographic map.

Location (Topographic) Map

The location drawing is used for detail planning and for staking out the job. It is commonly known as a plan view of the proposed works. Generally, it is drawn to a scale larger than the watershed map, but may be combined with a watershed map on some of the smaller jobs, especially on small drainage work. Discretion should be used in making such a combination, inasmuch as all information needed should be on such a map. It must be clear, understandable and without undue cluttering of the drawing. A location map should show as many of the following items as are needed in the design, construction, and future maintenance of the job.

1. Location of survey centerline, or other survey lines, with ties to permanent objects.

2. Location and plan view of all features (including horizontal dimensions) of proposed works with reference to survey lines.

3. Location and elevation of bench marks.

4. Location of existing watercourses, ditches, tile lines or other features when these affect design.

5. Location of soil borings.

6. Surface or subsurface water elevations at time of investigation.

7. Location of existing fences, property lines, buildings, roads, culverts, bridges, springs, wells, borrow pits, etc.

8. Contour lines.

Profiles and Cross Sections

To prepare engineering plans it is often necessary to have detail data showing the shape and elevation of the existing ground at the site. Normally, profiles and cross sections are used for obtaining and recording such field data. The detail and accuracy of the survey should be in line with the complexity of the site and the structure design.

Soils

The engineering qualities and land capabilities of the soil are important in determining the feasibility of a structure site or practice application. Logs of soil borings or other explorations are used to determine:

1. Adequacy of the foundation materials to support the structure.

2. Ability of a reservoir site to hold water.

3. Suitability of the materials for embankment or channel construction.

4. Drainability of soils for effective drainage systems.

5. Depth to rock, groundwater, or other conditions that may affect the structure.

The depth, method, and scope of the soil and foundation investigations will vary depending upon the size of structure and the hazard of the site. Often adequate investigation can be made with the soils auger. When observation of undisturbed materials is required, the use of heavy equipment such as backhoes and bulldozers has proven to be efficient and economical. All points at which investigations are made should be numbered and plotted on the plan map, and the findings recorded.

The technician should consult with soils and geology personnel if there is any question of suitability of the materials or site.

Hydrologic

Most conservation structures control, store, or provide discharge capacity for a certain volume or flow of water. The expected safety and efficiency of the structure is related to the accurate determination of the design runoff volume or peak discharge of the contributing drainage area or other source of supply.

The capacity of a structure installed to control unregulated streamflow often requires the collecting of existing rainfall and stream discharge records. The determination of design quantities, unless otherwise directed, is made by procedures outlined in Chapter 2 of this manual.

Hydraulic

Certain site data and capacity information are required to evaluate the hydraulic requirements of the structure. Items that often require consideration are:

1. Alignment and slope of stream or constructed channel.

2. Grades and cross sections.

3. Critical elevations.

4. Upstream and downstream capacities and controls.

5. Streambed conditions including bedload and deposition patterns that affect velocity and erodibility.

6. Rate of release from controlled supply.

7. Design flow from hydrologic data.

Assembly of Data

After collecting the necessary field and other pertinent data, it is important that all the facts and information be arranged and recorded in an orderly manner. Survey notes should be reduced and plotted in accordance with standard methods applicable to the job. Time can be saved by plotting field data to the scale and detail in the preliminary phase that will suffice for final design and preparation of plans for the project.

For many projects the use of prepared "work" or "job" sheets can be used to record all of the necessary data. These approved standard forms should be used, insofar as practical, for recording the data needed for analyzing the problem and the planning of a practical installation.

Analysis of Data

In reviewing the collected data, it is important to consider the relationship of the proposed solution to the overall use of the land. How will it affect needed practices to be installed in the future, and will the proposed practice be practical and needed if other measures are applied?

Detail review is necessary to determine:

1. The type or series of measures required.

2. The limitations in location and size of facility imposed by the site.

3. The design procedures and criteria that apply to the proposed structures or practices.

Throughout the process of analysis, consideration needs to be given to alternate methods and construction materials. A small additional outlay in installation cost may prove a saving in future maintenance and operation. All of these considerations should be discussed with the cooperator before preparing the final designs.

DESIGN

Design procedures include:

1. Rechecking or refining the estimated (Q) flow.

2. Hydraulic calculations to provide control, capacity, and safety.

3. Structure design.

4. Location, dimensions and elevations of important parts of the structure and its appurtenances.

5. Estimate of material quantities.

6. Specifications for materials and construction.

7. Estimate of construction costs.

Each phase of design should be performed by prescribed Service methods. It is important that design calculations be documented in a neat, orderly manner and checked for accuracy. Figure 5-2 illustrates a format for laying out a typical design problem, and a systematic procedure for documenting the work.

CONSTRUCTION DOCUMENTS

Drawings

The preparation of the construction plans or drawings consists of recording the design and structural requirements graphically in enough detail so that a technician unfamiliar with the project will have adequate information to lay out and see that the work is constructed as designed. Construction drawings for complex structures usually involve drafting the topographic, cross section and profile data collected in the investigation stage. Additional layout and detail drawings, as required, may be prepared as the design calculations are completed.

For many on-farm measures the preparation of the construction drawings may be simplified by using approved standard predesign layouts. The standard drawings (national and state forms) require careful review to see that: 1) The plan as drawn will fit the site so that the structure will function properly; and 2) all required dimensions, elevations and modifications are complete.

A common error in the preparation of the construction drawings is the omission of required details, sections, and dimensions. All plans should be carefully reviewed for completeness and accuracy before they are approved and delivered to the cooperator.

Specifications

In addition to the detail construction drawings, the construction plan often requires written specifications to clarify how the work will be done, the quality of workmanship, and methods of testing.

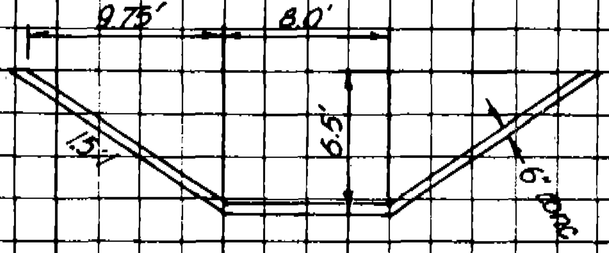
Another important phase of the specifications is the listing of the required quality of the manufactured materials that will be used in the work.

For small projects, the material and construction specifications may be documented in the form of notes on the drawings. For larger projects, the preparation of a separate specification document or the use of state standards is more practical. Otherwise the drawings become so cluttered they lose their usefulness.

Example Problem

STATE Your state		PROJECT Red Sands Irrigation Co.		
BY F.K.M.	DATE 1-15-68	CHECKED BY J.L.M.	DATE 1-17-68	JOB NO. BCSCD-10-68
SUBJECT Cost estimate, Lining - Kingman Lateral				SHEET 1 OF 2

Data: L = 1230'



Problem: 1. To determine volume of excavation
2. To determine volume of concrete
3. To prepare a cost estimate

Excavation - area of trapezoid × length

$$Area = (8.0 \times 6.5) + 2\left(\frac{6.5}{2} \times 9.75\right) = 115.4 \text{ sq ft}$$

$$Volume = (115.4 \text{ sq ft} \times 1230 \text{ ft}) = 141,942 \text{ cu ft}$$

$$\frac{141,942}{27} = \underline{5,257 \text{ cu yds}}$$

Note: Use left margin for scratch calculations

Dimensions used for quantity calculations are not exact in every detail. They represent common practice and suffice for field estimates.

Scratch calculations (left margin):

6.5×1.5: 325, 65, = 9.75

9.75×6.5: 4875, 5850, = 63.375

$6.5 \times 8.0 = 52.00$; $52.00 + 63.375 = 115.4$

115.4×1230: 34620, 2308, 1154, = 141,9420

$27 \overline{)141,942} = 5257$: 135, 69, 54, 154, 135, 192, 189, 3

Fig 5-2 Example format for documenting design calculations (Sheet 1 of 2)

5-10 Example Problem

STATE: Your state	PROJECT: Red Sands Irrigation Co.			
BY: F.K.M.	DATE: 1-15-68	CHECKED BY: J.L.M.	DATE: 1-17-68	JOB NO.: BCSCD-10-68
SUBJECT: Cost estimate, Lining - Kingman Lateral				SHEET 2 OF 2

6.5
6.5
325
390
42.25

Concrete volume - compute channel cross-section along Subgrade Surface.

6.50
1.5
3250
650
9.750
9.75
4875
6825
8775
95.0625

slope length $= \sqrt{6.50^2 + ((1.5)(6.50))^2}$

$\sqrt{42.25 + 95.06} = \sqrt{137.31}$

$= 11.7'$

X sectional length of lining

$(2)(11.7) + 8.0 = 31.4$ ft

42.25
95.06
137.31

concrete volume

$(31.4)(0.5)(1230) = 19{,}311$ cu ft

$\frac{19{,}311}{27} = 715$ cu yds

11.71
137.3100
1 | 1
21 | 37, 21
227 | 1631, 1589
2341 | 4200, 2341

15.7
1230
4710
314
157
19311.0

27) 19311.0 = 715.2
189
41
27
141
135
60

Cost Estimate

excavation - 5257 cu yds @ \$0.65/cu yd = \$3417.05
concrete - 715 cu yds @ \$80.00/cu yd = 57,200.00
\$60,617.05
say \$60,620

5257
.65
26285
31542
3417.05

715
80
57,200.00

Note: Normally these computations would be made on the slide rule. This problem was made to demonstrate problem analysis and setting the problem down on standard service computation sheets.

Fig. 5-2 Example format for documenting design calculations (Sht's 2 of 2)

Check List

The amount of detail required in the construction plans will vary with the type and size of the job. All jobs, regardless of size, should be adequately planned. The following list may be useful in checking the adequacy of the drawings and specifications:

1. Can the farm be located from the plans?
2. Is the project site clearly shown?
3. Can the survey lines be relocated and the job staked for construction as designed?
4. Are all dimensions and construction details clearly shown?
5. Are material and construction specifications complete for all parts of the work?
6. Are material quantities shown?
7. Has the title block been completely filled, including the date and who designed, drafted, and approved the work?
8. Has the cost estimate been prepared?

FINAL REVIEW AND APPROVAL

Before the construction plans are delivered to the cooperator a review of the design and construction plans should be made by a technician other than the one preparing the design.

When required, plans should be submitted to the appropriate state technical level for approval. The construction plans also should be properly signed and dated by all parties involved in their preparation and approval.

RECORDS

A complete copy of survey notes, useful basic data, soils logs, design calculations and other pertinent data, including a copy of the plans and specifications, should be assembled and filed in an orderly manner at the field location.

All structures or practices, regardless of type or kind of material, will require maintenance. Changes or additions made during construction should be recorded in colored pencil on the office copy of the plans. These "as built" plans often are useful when making maintenance recommendations to the cooperator. They also are useful to the Service for structural design improvement and evaluation of hydraulic performance. Complete "as built" records may be valuable in case of a legal dispute.

3. DRAWINGS AND DRAFTING STANDARDS

PREPARATION OF DRAWINGS

General

Drawings prepared in outline form, and standard job sheets are available in most states for many of the commonly used conservation structures and practices. These forms provide space for recording planning, layout, and construction details. Their use is applicable to the less complex jobs that require only the data suggested on the form to do an adequate job of planning and construction.

The technician should be aware of such State forms and state-selected national forms and use them insofar as they have application to the solution of the problem.

Kinds of Paper

Numerous kinds and types of engineering drafting paper are available through Service supply channels for use in preparing engineering plans. Due to the variance in kinds of practices encountered at the field level, it is not practical to present a list of drafting paper that may be required for all situations. The following kinds have universal use and are commonly stocked in field offices.

1. Profile - tracing or opaque, ruled 4 x 20 to the inch. Figure 5-3.

2. Plan Profile - tracing or opaque; upper one-half of the sheet blank and the lower one-half ruled 4 x 20 to the inch. Figure 5-3.

3. Cross Section - tracing or opaque; ruled 10 x 10 to the inch. Figure 5-3.

4. Plain White - tracing or opaque.

The profile and cross-section types of paper are recommended for use when plotting all kinds of profile or cross-section data, though the project may be small. The habit of documenting data in a systematic, acceptable manner speeds up plan preparation and helps to eliminate errors, both in design and construction.

The plan profile paper has dual use. The upper plain section is used to plot location, alignment, topographic features, etc. The lower half is used to plot ground and design profiles, which reflect the vertical control such as elevations, slopes, grade changes, size of pipe, etc. See example, Figure 5-4. The profile stationing should be directly related to the plan view presented on each sheet. For many small jobs this type of paper will be adequate to plan and construct the complete job.

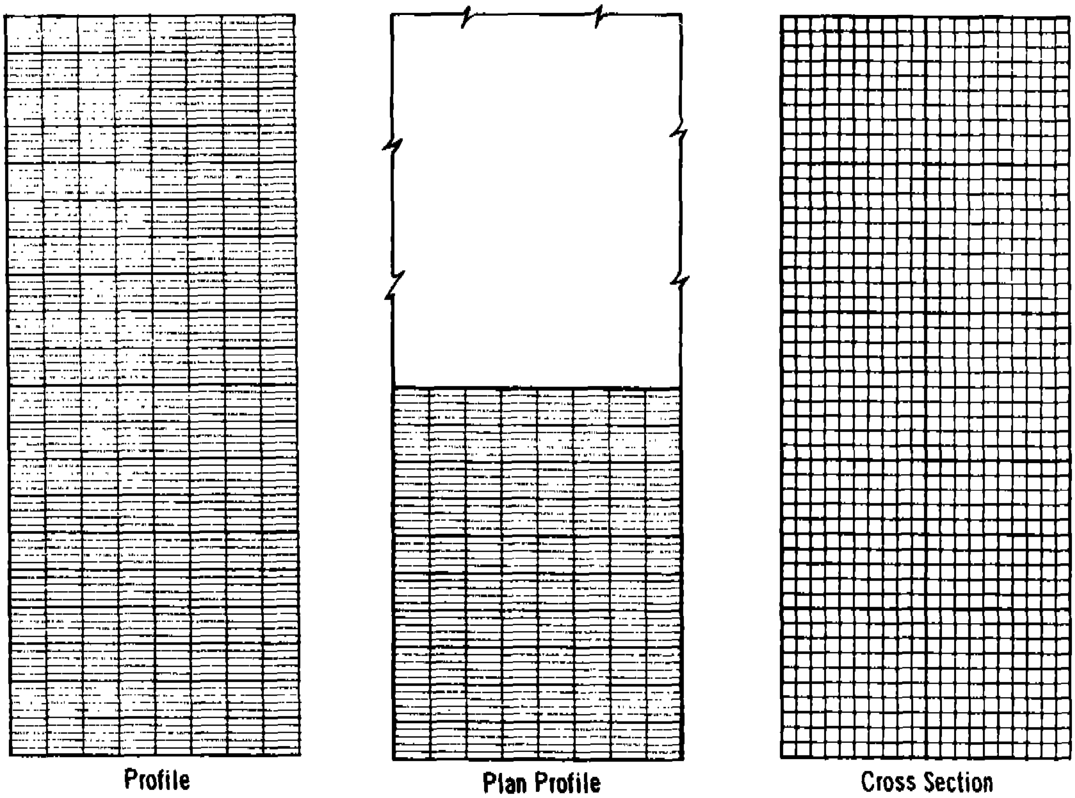


Figure 5-3. Sample paper - engineer rulings

Typical cross sections and structure details may be adequately arranged on the sheet to complete the plan.

Plain sheets are used for preparing watershed maps, location (topographic) maps and detail layout drawings.

Size of Drawing Sheets

All drawings for a job, regardless of kind of paper used, should be prepared on the same size sheet. This practice has advantage for use in the field, as well as appearance and ease of filing. The standard size sheets used by the Service should be used for all engineering drawings. The overall size and layout details, as suggested by the Cartographic Division, are shown in Figure 5-5.

The selection of the most practical size for a job is dictated by the size of the project. In no instance should the size or number of sheets be restricted to a degree that necessary sections and detail cannot be clearly shown to scale.

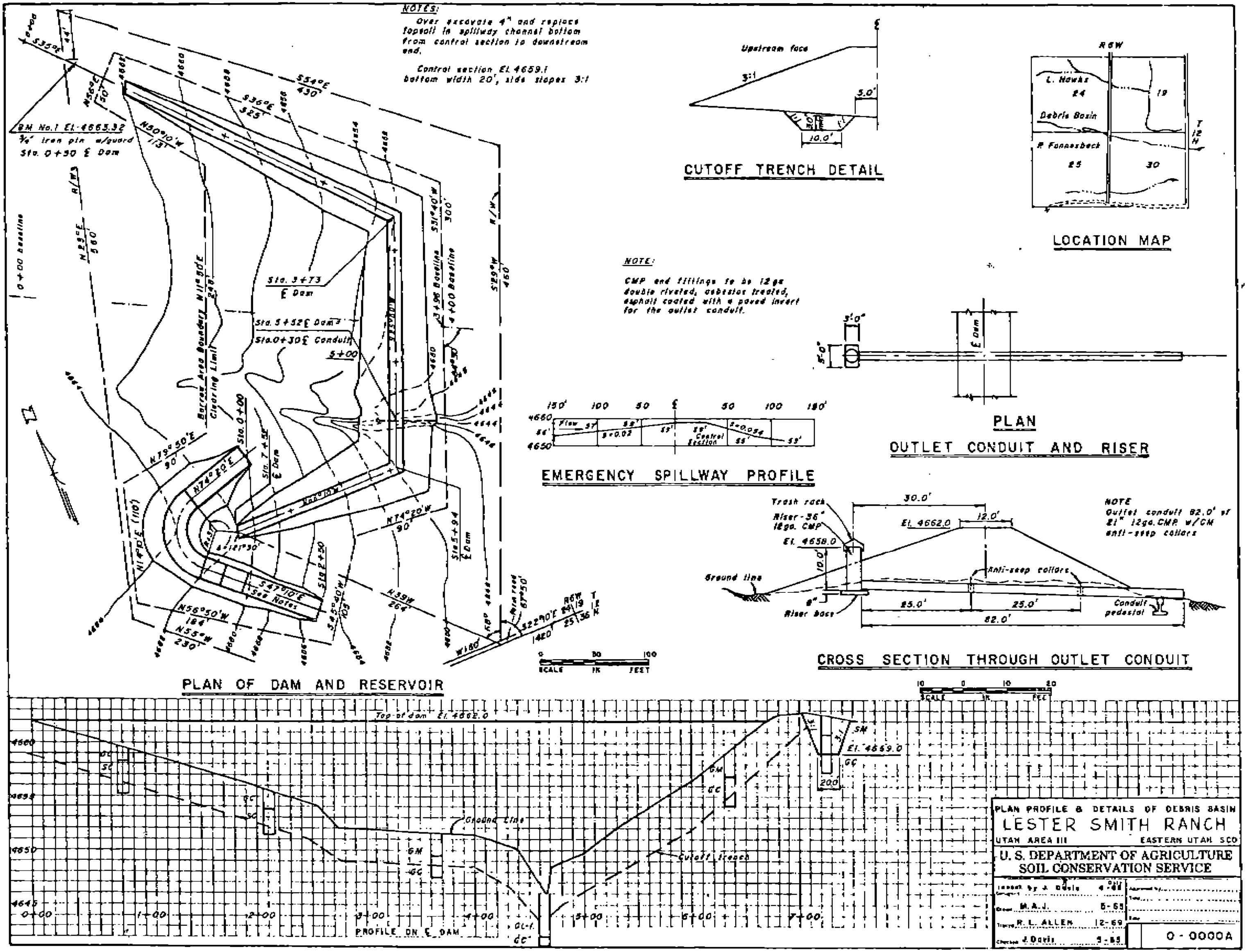
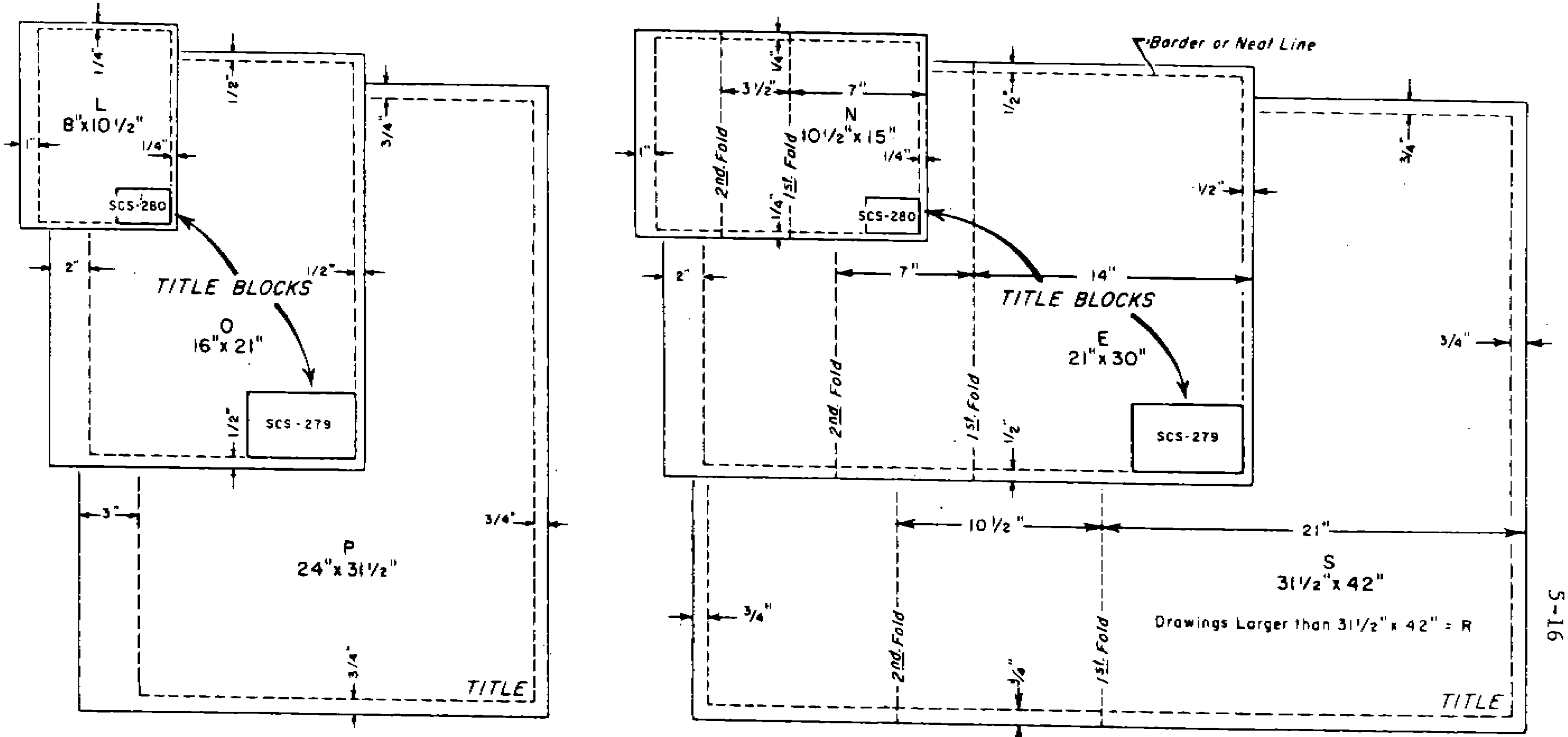


Figure 5-4 Example drawing using plan-profile paper



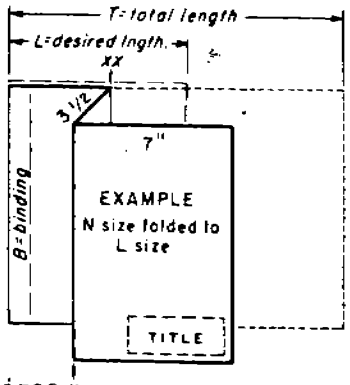
Title and File No. should be consistently graduated through all drawing sizes.

ACCORDION FOLD FORMULA

L - B = X (First Fold) —— 8" - 1" = 7"

$\frac{T-B-X}{2}$ = XX (Sec. Fold) —— $\frac{15"-1"-7"}{2}$ = 3 1/2"

Using this method, title is visible when sheet is bound.



NOTE: Sheets L, N, O and E are the only sheets authorized for engineering drawings.

Title Blocks should be used only on Engineering and Mechanical Drawings. Engineering Drawings require borders.

TITLE BLOCKS

DRAWING SIZE	DIMENSIONS
"L" and "N"	$1\frac{3}{4}$" x $2\frac{3}{4}$"
"O" and "E"	$3\frac{1}{2}$" x $5\frac{1}{2}$"

Figure 5-5 Standard drawing sizes

When conditions warrant, the layout may be drafted on a larger scale sheet for ease of drafting and then reduced in size by cartographic methods. This is the reason for the related dimensions specified for the standard sheet sizes.

Title Blocks

All sheets prepared for design and construction must have a title block. See Figure 5-6 for Service standard format. A smaller standard title block also is available. Each sheet should bear an individual number and a reference to the total number of sheets prepared for the work; i.e., sheet 2 of 4, 3 of 4, etc.

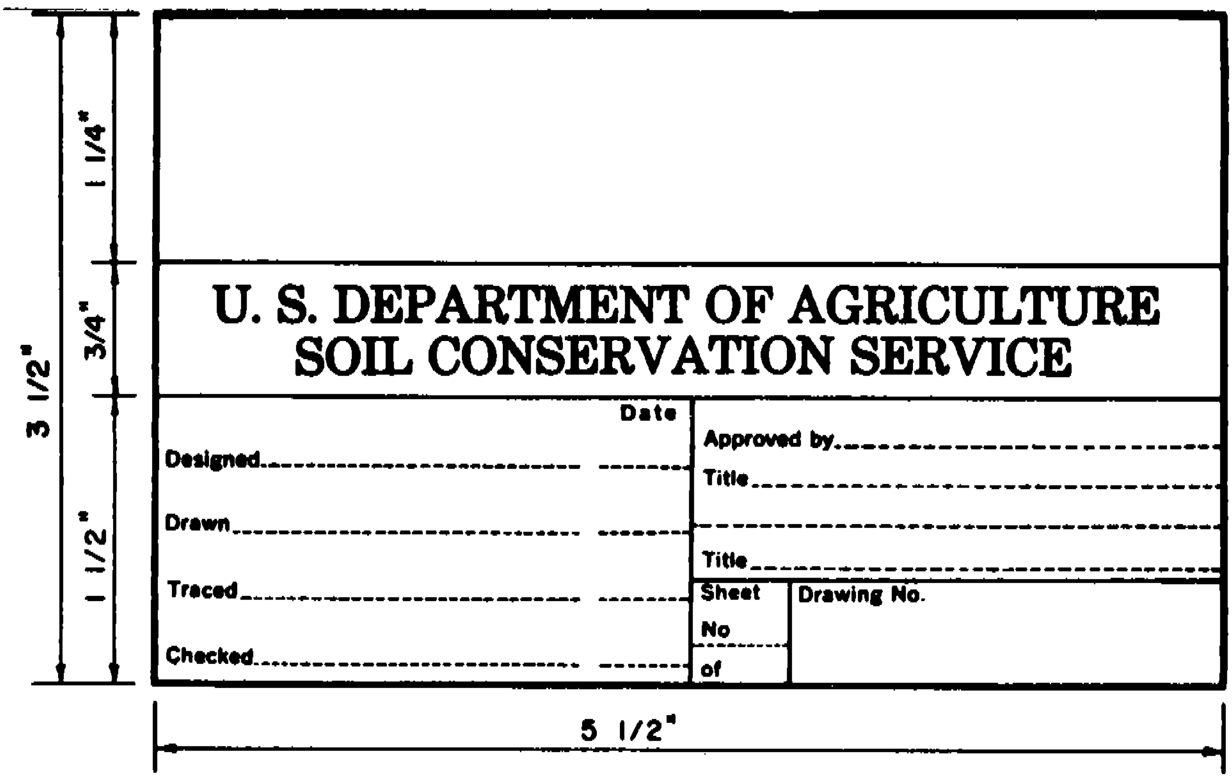


Figure 5-6. Large standard title block

The title block should present the following information in condensed form:

1. Subject matter represented by the drawing (plan, cross section, detail section, etc.). Use job stationing when applicable.

2. Name of project and cooperator or group.

3. Name federal department and Service responsible for preparing the drawings.

4. Name soil conservation district, county and state.

5. Name of persons who designed, drafted and checked the drawings with dates work completed.

6. Signatures of persons submitting and approving drawings, with dates.

7. A drawing number if applicable.

The kinds of drawing paper referred to herein may or may not have the title block printed on the sheets. Prepared title blocks in the appropriate sizes can be obtained as a press stickup which can be attached to the drawing. They may be used without any appreciable loss of clarity in reproduction.

The title block must appear in the lower right-hand corner of the drawing.

Scales and Plotting

Watershed Maps

Watershed maps should be prepared to a scale which will be adequate to record the detail information used in design. Often, the general outline of the watershed and other useful topographic features can be traced or reproduced from existing photos or maps. For small projects the field data may be plotted on an aerial photo.

The following scales are recommended for use in preparing maps or enlargements:

1 inch = 165 feet or 32 inches = 1 mile.

1 inch = 330 feet or 16 inches = 1 mile.

1 inch = 660 feet or 8 inches = 1 mile.

1 inch = 1320 feet or 4 inches = 1 mile.

Location (Topographic) Map

The size of the location map is related to the amount of data required to show the detail characteristics and related locations of the various phases of the work. When contours and other topographical features are complex a large size drawing will be required, as well as a scale using a smaller number of feet per inch. The technician should plan adequate space to prepare a clear presentation of the related topographical features and the necessary structure layout details. A portion of a structure that requires extra sections to show construction limits or detail layout or assembly may be drawn to an even larger scale.

The following scales may be taken as a guide:

Topographic Detail--Use an engineering scale for 1 inch = 20, 40, 50, 100 or 200 feet with contour lines shown 1-, 2- or 5-foot vertical intervals.

Structure Layout and Sectional Detail--Use an architect scale for 1 inch or fraction thereof = 1 foot for all structure or assembly dimensions. For example, 1/4 inch = 1 foot; 1/2 inch = 1 foot, 3/4 inch = 1 foot.

It is common practice to show all structure detail dimensions in feet and inches. The architect scale is subdivided to show feet and inches, which simplifies preparing the drawings to true scale.

Profiles

All profiles should be drawn on profile or plan-profile paper. In selecting the scale and starting point for plotting, first determine the total length and total difference in elevation from the field notes. Then select a horizontal scale and starting point so that the profile will be well spaced on the sheet, taking into account any other detail required to be shown on the drawing. The next step is to select a vertical scale and vertical starting point so that adequate vertical detail may be represented, keeping in mind required space for other drawings planned for the same sheet.

After selecting the starting point, the profile points are plotted at the proper location on both the horizontal and vertical scale. Adjacent related ground or planned profile points are connected by straight lines, using a triangle as a straightedge.

When approximately parallel lines are plotted on the same profile, such as opposite ditch banks, the representative lines should be labeled right and left bank as viewed in the direction of increasing stationing on the profile.

Designed gradelines, such as a proposed bottom of ditch or tile line, are represented by a heavy straight line connecting computed plotted points.

The horizontal scales for profiles should be 1 inch = 20, 40, 80, 100, 200 or 400 feet. Only the heaviest (10th vertical) lines are marked in stations. Using the above suggested scales, these heaviest lines would be 50, 100, 200, 250, 500 or 1,000 feet apart.

The vertical scale should be 1 inch = 2, 4 or 8 feet. Only the heavy (10th horizontal) lines are labeled. Using the above suggested scales the heavy lines would be 5, 10 or 20 feet apart. Every heavy line should be marked to show the complete elevation representing the datum used in the field survey.

Cross Sections

Cross sections should be plotted on cross-section paper (10 x 10 to the inch). They should be plotted as viewed when looking in the direction of increasing stationing of the survey; i.e., from Station 0+00 toward the next advancing station.

The complete profile station at which each cross section was taken should appear under the plotted section. At least two elevations should be shown along the left margin of the section to relate the survey elevations to the cross section as plotted.

The survey centerline, or reference lines used in the field for control, also may be shown on the cross section. For large sections it is helpful to establish horizontal stations for the section, usually stationed 0+00 at centerline and increasing both to the right and left of centerline.

When practical, the cross section should be plotted to the same horizontal and vertical scale, 1 inch = 5 feet, or 1 inch = 10 feet, thereby presenting an undistorted view. When this is not possible, these scales should be altered so that the full section can be shown on the sheet. In such cases, for example, the vertical scale may remain 1 inch = 5 feet or 10 feet, and the horizontal scale increased to 1 inch = 20 or 50 feet. All cross-section sheets should show the horizontal and vertical scale used for plotting.

Soil Logs

The soil borings or test pit data recorded in the field should be included on the construction drawings. All test sites should be accurately plotted to show location and elevation. Standard SCS legend symbols used for recording and plotting log information are shown in Figure 1-19, Chapter 1, of this manual. The boring logs should be plotted on the profiles or cross sections at the locations taken. When adequate room is not available, the location may be shown on the profile and the actual log presented to the side. When test sites do not appear on the profile, the location may be identified on the location map and the log data, properly identified, may be plotted on a separate sheet or at other convenient locations on the drawing.

A word description of the sample material, placed alongside the plotted boring, is helpful and saves time in referring to field data notebooks. Applicable ground water levels with date of observation should be shown on the logs.

The Unified Soil Classification System should be used to describe and log all applicable soil materials.

DRAFTING REQUIREMENTS

General

Engineering work sheets and other drawings prepared by work unit personnel are not expected to be of a drafting quality produced by a skilled draftsman. However, field personnel whose duties require the preparation of engineering drawings are expected to perform such work in a legible, neat, orderly and understandable manner. The appearance of the drawings will affect the degree of confidence with which they are accepted by cooperators and others in and outside the Service.

Equipment and Materials

Due to the various conditions found in work units, it is not possible to prepare a complete list of all materials needed in every work unit for preparing engineering plans. The following includes the drafting supplies generally required in preparing the normal kinds of engineering plans:

1. Paper - the types and kinds of paper listed are available in rolls or standard SCS size sheets with printed border lines and title blocks.

   Profile - tracing or opaque ("N" size SCS-316A; "E" size SCS-316)

   Plan profile - tracing or opaque ("N" size SCS-317A; "E" size SCS-317)

   Cross section - tracing or opaque ("N" size SCS-315A; "E" size SCS-315)

   Plain - tracing or opaque ("N" size SCS-313A; "E" size SCS-313 or 313C)

   Computation pads - SCS-522A or SCS-523 Rev.

2. Applicable standard state and national work sheets and predesign structure sheets.

3. Triangles - 45° and 30x60°.

4. Scales - 12-inch engineer's and 12-inch architect's.

5. Protractor - 360°.

6. Drafting board 3 feet x 4 feet (minimum) with T square.

7. Planimeter.

8. Minor items - F, HB, H, 2H, 3H, and 4H pencils, pencil sharpener, sandpaper pads, scissors, tape, thumb tacks, India ink, pens, lettering guide, etc.

Use of Pencil

Nearly all drawings made at the field level will be done in pencil. With reasonable care, a very creditable drawing can be prepared. If the proper weight lines are used, good photostatic or direct print reproductions can be made. The use of pencil eliminates a great deal of work normally required in making ink tracings. In some cases, however, it may be necessary to do considerable trial layout work in pencil on a contour sketch, as for a contour orchard or terrace system. In such cases it will be desirable to ink in the contours before beginning the trial layout work to avoid erasing the original contour lines.

Lettering

All lettering and numbers within the body of engineering sheets should be 3/20" high for capitals and 1/10" high for lower case letters. On the profile paper this is equivalent to three of the finest lines high for capital letters and two lines high for lower case letters. Titles in title block should be all capitals 1/4" high (five of the finest lines on the profile paper). Avoid the use of lettering any smaller than specified above if the drawings are to be reduced in size; otherwise, the lettering will be difficult to read.

The style of lettering used should be consistent with standard engineering practice. Elementary survey textbooks and the Service Cartographic Units provide examples of acceptable methods of forming letters and numbers. Each technician should practice to become proficient in making uniform lettering.

Standard Symbols

Symbols used in the preparation of maps and engineering plans should be consistent with the national cartographic mapping symbols. Figure 1-18, Chapter 1 of this manual, exhibits some of the more common symbols used in conservation planning.

For more detailed coverage, the technician is referred to the Standard Map Symbols for Soil Conservation Service.

Scales

The scale for all drawings and detail sections should be shown. Sketches or typical sections not drawn to scale should be so noted. For drawings which will not be reduced in reproduction, the numerical scale may be used; i.e., 1" = 100'. However, if the drawings are to be reduced, the numerical scale becomes useless unless the reduction ratio is known. In such cases a bar scale is required.

Reduction of the drawing does not affect the usefulness of this scale since it is reduced by the same ratio as the drawing. Figure 5-1 illustrates this type of scale.

The bar scale should be accurately drawn to the scale used for the view represented, and should include labeled subdivisions so that the use of the scale is simplified.

North Arrows

North arrows should be shown on each watershed map, location plan, and contour map. Technicians may use their own style north arrow so long as it is not too elaborate.

Prepared stick-on standard type north identifications are available from the Cartographic Units. Field locations preparing large numbers of engineering plans may justify maintaining a supply of this type drafting aid.

Legal Descriptions

The location of all proposed structures should be identified by some acceptable manner.

For structures requiring state or other agency approval it is necessary, in most instances, that the structure site be located by actual survey and referenced to accepted legal section or subdivision corners. The legal description should be checked to determine that the correct section, range and township numbers have been recorded.

It is desirable that other improvement sites are located within the proper section and subdivision as accurately as possible from existing map or field data. The legal land description and properly oriented structure site may be shown on the watershed or location map. For minor structures the legal site description may be included in the engineering plan title block.

General location information can be obtained from the Soil Conservation District Map, USGS quadrangle sheets, U. S. Forest Service maps and other acceptable maps.

Bench Marks and Transit Points

It is good engineering practice to establish well identified bench marks and transit points at the time of making the design survey. During the process of making the survey adequate location data should be obtained so that the necessary vertical and horizontal control may be plotted on the construction plans. This is an important detail since someone not familiar with the site may be required to do the construction layout.

In addition to showing the location of the bench marks, the correct elevation and description should be included.

Transit points set in roadways or other locations that may be disturbed prior to construction should be referenced by adequate ties. The description of the ties and location with distances to the transit point should be shown in the field notes and on the construction drawing.